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RESEARCHES ON THE RESPONSES OF DIFFERENT HYBRID LAYERS WITH RESPECT TO EGG PRODUCTION AND QUALITY PERFORMANCES TO FORCED MOLTING PROGRAMS WITH AND WITHOUT FEED WITHDRAWAL[1]

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ABSTRACT

This research was carried out to determine the effects of four forced molting programs including three non-feed withdrawal programs (BB: barley based, WB: wheat bran based and OB: oat based) which supplied with alfalfa meal and one feed withdrawal method (FW: control 8 d FW+34 d resting diet) on egg production and egg quality performances of 320 brown (H&N Brown Nick) and 320 white (Hy-Line W-36) hybrid layers at 57 week of age. The experiment lasted totally 46 wk including for a 6 wk molting period followed by a 40 wk post molt production period.

According to the results obtained; the genotype had significant (P<0.05) effect on body weight loss, feed consumption, hen day egg production (number, %), cracked egg (%) and heterophil:lymphocyte (H:L) ratio (P<0.01) in molting period. Molting methods had significant (P<0.01) effects on body weight loss, feed consumption, hen-day egg production (number, %), pancreas weight ratio in molting period. In the production period; BB group had lower (P<0.05) hen-day egg production (%) than those of OB and FW groups. Feed efficiency values of WB group were better (P<0.05) than the values of OB and FW groups. Hens molted by FW treatment had lower (P<0.05) albumen height and Haugh units than other treatments. As conclusion, after examining these production and quality criteria, it can be stated that; non feed withdrawal methods, especially OB program can be used alternative to FW program. But, other non-feed withdrawal programs also can be used successfully as molting procedure.

Key words: *Forced molting, Non-feed withdrawal, Egg production and quality, Heterophil:lymphocyte ratio*

FARKLI YUMURTACI HİBRİTLERİN, YEM ÇEKMELİ VE ÇEKMESİZ ZORLAMALI TÜY DÖKÜMÜ PROGRAMLARINA, YUMURTA VERİM VE KALİTE PERFORMANSLARI BAKIMINDAN TEPKİLERİ ÜZERİNE ARAŞTIRMALAR

ÖZET

Bu araştırma, yonca unu katkılı arpa esaslı, kepek esaslı ve yulaf esaslı üç adet yem çekmesiz ve bir adet yem çekmeli olmak üzere toplam 4 adet zorlamalı tüy döküm programının, 57 haftalık yaştaki 320 adet kahverengi (H&N Brown Nick) ve 320 adet beyaz (Hy-Line W-36) yumurtacı hibritlerde yumurta verim ve kalite performansları üzerine etkilerini incelemek üzere yapılmıştır. Araştırma, 6 haftası zorlanım peryodu, 40 haftası da verim dönemi olmak üzere toplam 46 hafta sürdürülmüştür.

Elde edilen sonuçlara gore, zorlanım peryodunda genotipin, canlı ağırlık kaybı (P<0.05), yem tüketimi, tavuk gün yumurta verimi (adet, %), % kırık yumurta oranı ve heterofil: lenfosit (H:L) oranı (P<0.01) üzerine etkisi önemli çıkmıştır. Zorlanım programlarının, canlı ağırlık kaybı, yem tüketimi, tavuk gün yumurta verimi (adet, %) pankreas ağırlığı oranı (%) üzerine etkisi önemli (P<0.01) olmuştur. Verim döneminde, arpa esaslı grup yulaf esaslı ve yem çekmeli gruba göre daha düşük (P<0.05) tavuk gün yumurta verimi (%) vermiştir. Kepek esaslı grup, yulaf esaslı ve yem çekmeli gruplara göre daha iyi (P<0.05) yem değerlendirme katsayısı (g yem/ g yum)' na sahip olmuştur. Yem çekmeli grubun yumurta ak yüksekliği ve Haugh değeri diğer yem çekmesiz gruplara göre daha düşük (P<0.05) olmuştur. Sonuç olarak, tüm bu verim ve kalite kriterleri incelendiğinde, yem çekmesiz programlar, özelllikle yulaf esaslı grup yem çekmeli programa alternatif olarak kullanılabileceği kanaatine varılmıştır. Ancak, diğer yem çekmesiz programlarla da başarılı bir şekilde tüy dökümünün yapılabileceği belirlenmiştir.

Anahtar Kelimeler: *Zorlamalı tüy dökümü, Yem çekmesiz program, Yumurta verimi ve kalitesi, Heterofil:lenfosit oranı*

INTRODUCTION

Induced molting of laying hens is a widely utilized management technique in the commercial egg industry to extend the productive life of a flock. The main purpose of molting is to cease egg production in order to enter hens to a non reproductive state, which increase egg production and egg quality postmolt (Webster, 2003). There are several molting methods. Feed to withdrawal (FW) has been the most popular due easy of application, economic benefits and agreeable postmolt performance (Bell, 2003). However, recent concerns have been raised about animal welfare during the FW period because it is thought to be harmful to hens (Webster, 2003) and hens undergoing fasting appear to be more susceptible to *Salmonella enterica*

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serovar Enteritidis (*S. enteritidis*) colonization of the gastrointestinal tract and infections (Holt 2003, Ricke 2003) and weakening of the immune response (Holt, 1992). It has been reported that leukocyte numbers decreased and differential leukocyte populations changed during different molting regimes (Alodan and Mashaly, 1999). Davis et al. (2000) reported that hens in caged layer system undergoing molting by feed restriction showed a significant increase in heterophil to lymphocyte ratio. Decrease in efficiency of heterophil functionality has also observed in hens deprived of feed (Kogut et al. 1999). Efforts have been made to reduce or even eliminate the use of such programs that require complete removal of feed from hens. For this reason, alternative methods that do not require complete removal of feed are being considered (Donalson et al. 2005). Historically researchers have examined alternative diets to FW that provide similar benefits while not altering the health of the animals. In the past, studies have been conducted using diets mixed with high zinc concentrations (Sarıca et al. 1996, Bell 2003 ve Bar et al. 2003) and low sodium concentrations (Berry and Brake 1985) to induce molt. However, such diets have yielded inconsistent results, are costly, and can cause such as cannibalistic pecking (Webster 2003, Biggs et al. 2004), osteoporosis and temporary paralysis (Webster, 2003). Recently, the use of insoluble plant fibbers have been investigated and successful alternative molt induction diets have been developed from grape pomace, wheat middling, cottonseed meals, jojoba meal and alfalfa meal (Vermaut et al. 1997, Seo et al. 2001, Davis et al. 2002, Keshavarz and Quimby 2002, Biggs et al. 2003, Biggs et al. 2004, Landers et al. 2005 ve Donalson et al. 2005). The objective of the current study was to examine the use of diets high in barley, oat and wheat bran or corn, readily available and inexpensive feed ingredients in Turkey, as alternatives to fasting for induced molting of laying hens.

MATERIALS AND METHODS

An experiment was conducted using 320 Hy-Line W-36 and 320 H&N Brown Nick hens (57 wk of age). Hens were housed 4 per cage for the molting procedure. The hens were divided into 8 treatment groups: FW (control); BB (70% barley and 27% alfalfa); WB (32% wheat bran, 44% corn and 21% alfalfa) and OB (70% oat and 27% alfalfa) for Hy-Line W-36 and H&N Brown Nick, each treatment having four replicate of 20 hens. The three diets were formulated to containing no salt, 1% Ca, 0.5% non-phytate P and 10% and more crude fiber using NRC (1994) table values. Vitamin and amino acid (as percent of crude protein) contents of the experimental diets were supplied adequately considering the management guides of used hybrid genotypes. All treatments were allowed adlibitum access to water and their respective diets. On day 1, the photoperiod was reduced to 10 h. On day 43, the daily photoperiod was increased 30 min/wk for 12 wks until a 16-h photoperiod was established. The experiment consists of a 6-wk molt period followed by a 40-wks post molt production period. Blood samples were taken from the wing vein from 2 hens per replicate group from the FW, BB, WB and OB treatments for a total of 8 hens per treatment on day 0 and 42. In addition, blood samples were also taken from the hens in FW treatment on day 8. Each hen sampled on day 0 was leg-banded after blood was drawn, and the same hen from each replicate group was sampled on day 42. One drop of blood smeared on each of 2 glass slides. The smears were stained with May-Grunwald-Giemsa stain (Konuk, 1975). On the total leukocyte count were includes heterophils, lymphocytes, monocytes, basophils and eosinophils. About 100 cells were counted for each ratio. The heterophil:lymphocyte ratio was calculated by dividing the number of heterophils by that of lymphocytes (Gross and Siegel, 1983). The means of the 2 slides were calculated for each bird.

FW treatment, which was carried out with 8-d feed withdrawal, was followed by feeding a resting diet (13% CP and 2500 Kcal/kg ME) for 32 d and three other treatments were provided adlibitum for 42 d with their own diets. On d 43, all hens were placed on a 15.5% CP layer diet (Table 1). At the end of the molt, 64 hens were euthanized and the ovary, spleen, pancreas and liver were excited aseptically and weighted and expressed as relative weights (% of BW). Egg production performance was measured for 46 wks following the initiation of feed withdrawal or feeding the molt diets. Egg production and mortality were recorded daily throughout the 46-wk experimental period. Haugh units, egg specific gravity, albumen height and shell thickness were measured on five eggs per replicate group at every week beginning from wk 14 to 30. Albumen height was measured using a micrometer and recorded to the nearest 0.1 mm. Egg specific gravity was measured by Archimedes methods (Wells, 1968). Egg weight was measured on all eggs produced on two consecutive days. Egg mass (g egg/hen per day) were calculated using hen-day egg production and average egg weight. During molt, hen weights were monitored at d 1 and 42. Body weights of hens deprived of feed for 8 d were measured on d 8. Feed consumption was measured in every four week for production period (wk 1 to 40). Feed efficiency (g of feed /g of egg) was calculated using feed consumption and average egg weight.

All percent data were tested for normality (Shapiro-Wilk's test) and abnormal data were transformed to *arc sin* to normalize them prior to statistical analysis (Yurtsever, 1984). Collected data were analyzed as to the factorial (2x4) randomized plot design (Düzgüneş et al. 1987). Differences between treatment groups were determined using Duncan's multiple range tests (Düzgüneş et al. 1983). The statistical analyses were conducted using the Balanced ANOVA procedure of MINITAB (2000). The significant differences be-

tween means were obtained by MSTAT-C Range Program (1989) using Duncan's Multiple Range Test.

RESULTS AND DISCUSSION

There were no significant differences for mortality between treatments during the molting period. Mortality of the HL and BN hens fed the BB diet was 1.25%. Mortality rate of HL hens (%1.25) on BB program were found similar with the results of Biggs et al. (2003), and it is found comparable with the mean values reported by Biggs et al. (2004) that is between 0 to 2.4 % for non-FW programs. Mortality rate of BN hens on BB program (1.25%) was lower than value (2.60 %) determined by Petek (2001) for non-FW programs. Mortality rate of other without and with FW programs were found almost 0 %.

HL and BN hens lost 13.36% and 11.50 %, respectively, of their initial body weight ($P<0.05$) at the end of the molting period. HL and BN hens deprived of feed for 8 d lost 23.5% and 22.8%, respectively, of their original body weight at the end of their feed removal period. By the end of the 42-d molt period, HL hens and BN hens then fed the resting diet had regained a substantial amount of weight and had final body weight losses of 6.01% and 5.25%, respectively. Body weight losses of the HL hens on BB (15.22%) and on OB (17.34%) programs and body weight loss of BN hens on WB program (17.15%) are in agreement with the report of Ruszler (1998) who states that for successful molting the body weight loss should be between 15 to 40% during molting period. Body weight loss values of HL hens on OB program (17.34%) and BB program (15.22%) are similar to the values reported by Biggs et al. (2003) and Landers et al. (2005). Low body weight loss values (5.63%) obtained from FW groups was due to the resting diet (2500 ME, 13% CP) given to the birds after the feed withdrawal period of 8 days. As a result, it can be stated that more starved animals consume more feed to compensate the body weight loss. The animals in this group (FW) consumed more feed than the other groups during the rest of the molting period even that were not fed for 8 days. For desired level of weight loss, it can be suggested that resting diets having less condensed nutrient densities is suitable, if only the production performance after this diet is not adversely affected.

Table 1. Composition of experimental molting diets, resting diet used after feed withdrawal and the layer diet used in post molt production period

Ingredients and analysis	Barley based (%)	Oat based (%)	Wheat bran-corn based (%)	Resting diet (%)	Layer diet (%)
Corn, yellow (8.8%)	--	--	43.67	55.89	65.42
Alfalfa (13%)	26.97	27.47	21.16	--	--
Oat (11.4%)	--	70.00	--	--	--
Barley (11.6%)	70.00	--	--	--	--
Soybean meal (43%)	--	--	--	4.98	18.56
Sunflower seed meal (36%)	--	--	--	--	4.75
Wheat bran (15.7%)	--	--	32.15	35.47	--
Limestone	0.342	0.030	0.688	1.479	7.997
Dicalcium phosphate	2.198	2.152	1.829	1.742	1.924
Salt	--	--	--	--	0.176
Vit-Min. Premix[1]	0.250	0.250	0.250	0.250	0.250
DL-Methionine, 98%	0.114	0.074	0.099	0.083	0.091
L-Lysine	0.126	0.024	0.154	0.106	--
Vegetable oil	--	--	--	--	0.832
Total	100	100	100	100	100
Calculated analysis[2]					
Crude protein (%)	11.8	12.2	11.84	13	15,5
Metabolizable energy (kcal/kg)	2207	2133	2200	2500	2800
Crude fiber (%)	10.6	10.5	10	5.29	1.44
Calcium (%)	1	1	1	1	3.60
Available phosphorus (%)	0.5	0.5	0.5	0.5	0.45
Sodium (%)	0.062	0.071	0.052	0.160	0.188
Lysine (%)	0.531	0.550	0.533	0.585	0.733
Methionine + cystine (%)	0.449	0.464	0.449	0.490	0.603
Threonine (%)	0.438	0.412	0.415	0.461	--
Tryptophan (%)	0.156	0.191	0.179	0.189	0.194

[1] *Provided per kilogram of diet; vitamin A, 12000 I.U; vitamin D_3, 2400 I.U; vitamin E, 25.0 mg; vitamin K_3, 4.0 mg; vitamin B_1 (thiamine), 3.0 mg; vitamin B_2 (riboflavin), 5.0 mg; vitamin B_6, 8.0 mg; vitamin B_{12}, 0.015 mg; niacin, 25.0 mg; calcium-D-pantothenate, 8.0 mg; D-Biotin, 0.05 mg; folic acid, 0.5 mg; choline choride, 125.0 mg; manganese, 80.0 mg; iron, 60.0 mg; zinc, 60.0 mg; copper, 5.0 mg; iodine, 1.0 mg; cobalt, 0.2 mg; Selenium, 0.15 mg.*

[2] *Based on NRC (1994) feed composition tables.*

At HL hens that were deprived of feed for 8 d and hens fed the OB diet ceased egg production by d 6. None of the hens in the other HL groups totally ceased egg production during the molting period. Hen-day egg production of HL hens in OB program decreased to 0% on the 6th day which is in agreement with the values of Biggs et al. (2003) and Donalson et al.

(2005). At BN hens that were deprived for 8 d ceased egg production by d 7. None of the hens on the other BN hens groups totally ceased egg production during the molting period. HL hens showed lower (P<0.01) egg production (10.99%) than BN hens (24.39%) during the molting period. In the other programs without feed withdrawal, there were decreases in egg production but never reached to 0%. This result is also in agreement with the results of Biggs et al. (2003) and Biggs et al. (2004). Hen-day egg production during the molting period are shown in Table 2. HL hens that fed the OB diet (6.46%) exhibited more (P<0.01) decreases in egg production than hens fed the WB diet (12.77%) and FW treatment (14.41%) but were not different from BB treatment. BN hens that fed the OB diet (12.83%) exhibited more (P<0.01) decreased in egg production than hens fed the WB diet (22.89%), fed the BB diet (29.81) and FW treatment (32.03%).

HL hens that fed the OB diet (53.44 g) and BB diet (55.16 g) exhibited lower (P<0.01) feed consumption than WB diet (65.94 g) and FW treatment (78.65 g). BN hens that fed the OB diet (73.71 g), BB diet (75.79 g) and WB diet (79.73 g) exhibited lower (P<0.01) feed consumption than FW treatment (Table 2).

On day 0 and 42 of the molting period heterophil:lymphocyte ratio of HL hens were lower (P<0.01) than of BN hens (Table 2). On the other hand, there were no significant differences in the heterophil:lymphocyte ratio between forced molting programs at d 0 and 42 of the molting period. The FW method has reached almost four times of heterophil:lymphocyte ratio (0.34; 1.26) at d 8 of the molting period as to beginning molting periods.

Table 2. Effect of different genotype and forced molting programs on body weight loss, egg production, feed consumption and heterophil:lymphocyte ratio during the 6-wk of molting period ($\overline{X} \pm S_{\overline{X}}$).

Genotype		Body weight loss (%)	Egg Production (Hen-day, %)	Feed consumption (g/hen/day)	H: L ratio	
					d 0	d 42
HL		13.36±0.694	10.99±0.983	63.30 ± 2.747	0.27±0.009	0.55±0.017
BN		11.50±0.675	24.39±1.974	83.62 ± 3.280	0.42±0.013	0.68±0.017
Mean		12.43±0.488	17.69±1.620	73.46 ± 2.786	0.34±0.011	0.62±0.013
Significance		*	**	**	**	**
FM Programs						
FW		5.63±0.878^{c}	23.22±3.545^{a}	91.96±5.276^{a}	0.34±0.025	0.62±0.026
BB		14.01±0.685^{b}	20.06±3.700^{b}	65.48±3.937^{c}	0.33±0.022	0.67±0.028
WB		16.02±0.656^{a}	17.83±1.994^{b}	72.83±2.651^{b}	0.34±0.029	0.60±0.027
OB		14.07±0.755^{b}	9.64±1.361^{c}	63.57±3.884^{c}	0.34±0.019	0.60±0.023
Significance		**	**	**	NS	NS
Genotype x FM Programs						
HL	FW	6.01+1.425^{d}	14.41±2.248^{c}	78.65 ± 3.420^{b}	0.27±0.027	0.54±0.021
	BB	15.22±0.824^{a}	10.32±0.720^{cd}	55.16 ± 1.072^{d}	0.27±0.022	0.62±0.035
	WB	14.89±0.973^{ab}	12.77±0.774^{c}	65.94 ± 0.956^{c}	0.27±0.015	0.53±0.039
	OB	17.34±0.608^{a}	6.46±1.113^{d}	53.44 ±1.338^{d}	0.27±0.012	0.55±0.049
BN	FW	5.25±1.056^{d}	32.03±1.352^{a}	105.28±0.182^{a}	0.42±0.024	0.70±0.041
	BB	12.79±1.045^{bc}	29.81±0.256^{a}	75.79 ± 0.499^{b}	0.42±0.016	0.72±0.039
	WB	17.15±0.828^{a}	22.89±0.940^{b}	79.73 ± 0.438^{b}	0.42±0.032	0.67±0.028
	OB	10.80±0.918^{c}	12.83±0.804^{c}	73.71 ± 0.349^{b}	0.42±0.025	0.63±0.013
Significance		**	**	**	NS	NS

** - Significant (P <0.05); ** - Significant (P <0.01); NS – No Significant; HL - White egg layer (Hy-Line W-36); BN- Brown egg layer (H&N Brown Nick); FM - Forced molting; FW - Feed withdrawal; BB - Barley based; WB - Wheat bran-corn based; OB - Oat based*

H:L ratio obtained at the end of the 42th day from HL groups on the WB and OB programs (0.53, 0.55) were found similar with the value (0.54) found at the study of Biggs et al. (2004) which obtained at 28th day. However, even if the differences were not significant, H:L ratio of OB and WB groups were found better than the others. At the end of the molting period, the H:L ratio were found approximately two times to the pre molt period values. But, at 8th day of FW, H:L ratio were found 4 times as to the pre molt period values. According to the these results, it can be stated that H:L ratio is elevated with FW treatment, but it is not already determined that "What is the tolerable H:L ratio of the hens?", also considering genotypes.

The organ weights were assessed based on body weight percentage for the birds in the molting treatments (Table 3). No significant difference (P>0.05) in

ovary, liver, spleen weights were observed between genotypes and forced molting programs. Ovarian weights (as % of BW) of HL hens fed on FW, BB, WB and OB diets were found as 0.208%, 0.288%, 0.285% and 0.265%, respectively. Also, ovarian weights (as % of BW) of BN hens fed on FW, BB, WB and OB diet were found as 0.418%, 0.370%, 0.350% and 0.265%, respectively. Ovarian ratio (0.265%) obtained in OB program was lower than the value (0.45%) reported by Donalson et al. (2005).

Liver weights (as % of BW) of HL hens fed the FW, BB, WB and OB diets were found as 1.558%, 1.698%, 1.615 %, and 1.753 %, respectively. Also, liver weights of BN hens fed on FW, BB, WB and OB diets were found as 1.905%, 1.768 %, 1.555% and 1.640 %, respectively. Liver ratio (1.753%) of HL in OB program was similar to Donalson et al. (2005).

In addition, spleen weights (as % of BW) of HL hens fed on FW, BB, WB and OB diets were found as 0.113%, 0.108%, 0.105% and 0.100%, respectively. Spleen weights of BN hens fed on FW, BB, WB and OB diet treatments were found as 0.100%, 0.095%, 0.120% and 0.125 %, respectively. Spleen ratio (0.110%) of HL obtained from the programs without feed withdrawal was similar to the values (0.11%) of Donalson et al. (2005) and the value (0.10%) of Landers (2004).

Pancreas weights (as % of BW) of HL hens fed on FW, BB, WB and OB diet treatments were found as 0.168%, 0.223%, 0.178 and 0.185%, respectively. Also, pancreas weights of BN hens fed on FW, BB, WB and OB diet treatments were found as 0.173%, 0.203%, 0.160% and 0.170%, respectively.

Table 3. Effect of different genotype and forced molting programs on post molt organ weights (%; $\overline{X} \pm S_{\overline{X}}$).

Genotype		Liver	Spleen	Ovary	Pancreas
HL		1.656±0.0507	0.106±0.0046	0.261±0.0291	0.188±0.0071
BN		1.717±0.0614	0.110±0.0053	0.351±0.0216	0.176±0.0063
Mean		1.686±0.0395	0.108±0.0035	0.306±0.0195	0.182±0.0048
Significance		NS	NS	NS	NS
FM Programs					
FW		1.731±0.1094	0.106±0.0065	0.313±0.0470	0.170±0.0027[b]
BB		1.733±0.0650	0.101±0.0072	0.329±0.0427	0.213±0.0063[a]
WB		1.585±0.0587	0.113±0.0068	0.318±0.0412	0.169±0.0088[b]
OB		1.696±0.0775	0.113±0.0077	0.265±0.0264	0.178±0.0084[b]
Significance		NS	NS	NS	**
Genotype x FM Programs Programs					
HL	FW	1.558±0.0909	0.113±0.0125	0.208±0.0507	0.168±0.0025
	BB	1.698±0.0924	0.108±0.0085	0.288±0.0814	0.223±0.0103
	WB	1.615±0.0677	0.105±0.0126	0.285±0.0602	0.178±0.0138
	OB	1.753±0.1502	0.100±0.0000	0.265±0.0520	0.185±0.0119
BN	FW	1.905±0.1656	0.100±0.0041	0.418±0.0197	0.173±0.0048
	BB	1.768±0.1019	0.095±0.0119	0.370±0.0274	0.203±0.0125
	WB	1.555±0.1043	0.120±0.0041	0.350±0.0600	0.160±0.0108
	OB	1.640±0.0584	0.125±0.0132	0.265±0.0233	0.170±0.0122
Significance		NS	NS	NS	NS

** - Significant (P <0.05); ** - Significant (P <0.01); NS – No Significant; HL - White egg layer (Hy-Line W-36); BN- Brown egg layer (H&N Brown Nick); FM - Forced molting; FW - Feed withdrawal; BB - Barley based; WB - Wheat bran-corn based; OB - Oat based*

Pancreas ratio (0.168%) of HL in FW group was similar with the result of (0.19%) the study of Küçükyılmaz et al. (2003) which the animals were not fed for 8 days.

While hen-day (%) egg production effected (P<0.05) by molting programs, hen-housed egg production (%) not effected by any treatments involved in this research.

BB treated hens (71.29%) exhibited lower (P<0.05) post molt hen-day egg production than FW (74.60%) and OB treatment (74.90%), but were not different from WB treatment (Table 4). There were no significant difference between in FW (74.60%), WB (72.42%) and OB (74.90%) treatments. Hen-day egg production (73.05 %) of HL hens fed the OB diet were found higher than Donalson et al (2005) and Biggs et al. (2004), and lower than value (74 %) reported by Biggs et al. (2003) obtained by a molting program of without FW based on wheat middling. Hen-day egg production value (71.33 %) of BN hens fed the BB diet were found higher than values reported by Yılmaz and Şahan (2003) and Petek (2001).

Post molt egg weight, egg mass, feed consumption and cracked egg (wk 1 to 40) are depicted in Table 4. All the treatments did not show significant differences for these four parameters. Daily egg mass (g) produced per hen was not affected by any treatment (Table 4). BN hens produced daily 2.8 g more (P<0.01) egg mass than HL hens. Egg mass obtained from white egg laying HL hens on WB and BB molting programs (47.94 and 47.52 g/hen/day) similar to values reported by Biggs et al. (2003), but higher than values obtained with forced molting program conducted by Biggs et al. (2004). There was no significant difference with respect to egg mass between the molting programs. It seems that non-FW programs can be an alternative to the FW programs at least for this reason.

Cracked egg ratio (1.72%) of BN hens on BB programs was found fairly lower than value (10.89%) reported by Petek (2001). This is economically important, because of the cracked egg ratio decreases, the saleable egg ratio would increase. Even if there is no significant difference between molting programs, non-FW programs showed less cracked egg ratio than the FW program.

No significant differences were found among treatments for viability (mortality). There were no mortality in HL hens fed the WB diet and in BN hens fed the BB diet. The mortality level (4.17%) in HL hens on BB program was found similar with the value (4.8 %) reported by Biggs et al (2003). On the other side, mean mortality level of BN hens on BB program was determined as 0 % and found better than value (5.2 %) reported by Yılmaz and Şahan (2003).

Egg weight was not affected by any treatment. Mean egg weight (66.22 g) value obtained from HL hens on OB program was higher than values (64.07, 65.6 g) obtained by Landers (2004) and Landers et al. (2005), but lower than value (70.78 g) obtained by Donalson et al. (2005). On the other side, mean egg weight (66.70 g) of the same layer group on BB program was found higher than value (65 g) obtained by Biggs et al (2003), but similar to value (67 g) reported by Biggs et al (2004). Also, mean egg weight (69.21) of BN hens fed the BB diet was found higher than values reported by Petek (2001) and Yılmaz and Şahan (2003). With respect to egg weight, non-FW programs had been alternative to the FW programs in this study.

Feed consumption not effected by any treatment groups. Mean daily feed consumption (114.67 g) of HL hens on WB program was found higher than value (109 g) reported by Biggs et al (2003), but similar to the value (114 g) reported by Biggs et al. (2004). On the other side, mean daily feed consumption (119.78 g) of BN hens on BB program was found higher than value (105.09 g) reported by Petek (2001).

Feed efficiency was effected (P<0.05) by molting programs, but neither genotype nor interaction effects. WB treatment hens (1.73) exhibited better (P<0.05) feed efficiency (FE) than OB (1.82) and FW treatment (1.80) but were not different from BB treatment (1.75). FE value (1.7 g feed/g egg) of HL hens on WB and BB programs was found better than values reported by Biggs et al. (2003) and Biggs et al. (2004). While OB and FW groups having similar FE, better FE had been determined in WB group. This may be due to low feed consumption and heavy egg production in post molt production of WB group.

Interior and exterior egg qualities were examined in this study to determine if the different genotype and diets containing levels of oat, barley, wheat bran and alfalfa would alter post molt quality of eggs (Table 5).

Albumen height and Haugh units (HU) were lower (P<0.05) for FW treatment when compared with BB, WB and OB treatments. Mean albumen height value (7.30 mm) of eggs from HL hens was found higher than values (5.99 and 6.21 mm) reported by Landers (2004) and Landers at al. (2005), respectively, and lower than value (8.31 mm) reported by Donalson et al. (2005). Mean albumen height (7.07 mm) of eggs from BN hens on BB program higher than value (6.01 mm) obtained by Yılmaz and Şahan (2003). According to the these result; even if the eggs having higher albumen height can be stored longer than those of eggs having normal albumen height,it can be stated that FW program seems more disadvantageous than non-FW programs.

Similarly, the BN hens had lower albumen height and Haugh units than HL hens. Mean HU value (82.9) of the HL hens on OB program was determined lower than value (85.02) reported by Donalson et al. (2005). But, HU value obtained from BN hens on BB program was found (80.57) higher than value (74.78) reported by Yılmaz and Şahan (2003). It is well known that albumen height and HU are highly correlated (r=0.98) (Durmuş, 2006). So, we consider that higher HU value is the reason of albumen height obtained with non-FW programs as to the FW program.

Mean specific gravity (SG) value (1.079) of eggs obtained from HL hens was found higher than value (1.077) reported by Donalson et al. (2005). As to the reports of De Ketelaere et al. (2002) and Keshavarz and Quimby (2002), in case of higher SG, the egg shell thickness is thicker than normal situation and this is important for the egg industry. Also, as it can be seen from Table 5 that higher SG is matching with higher egg shell thickness and this result is in harmony with the above reports.

It is well known that SG is highly correlated with egg shell strength and is a method of determining egg's strength without broken it (Card and Nesheim 1979, North and Bell 1990). So, it is hoped that with a fairly higher SG, table eggs can be graded, transported, packaged and sellable egg portion will be elevated (North and Bell, 1990).

Table 4. Effect of different genotype and forced molting programs on the production performances during the 40 wks of post molt ($\overline{X} \pm S_{\overline{X}}$).

Genotype		Hen-day (%)	Hen-housed (%)	Egg mass (g egg/hen per d)	Cracked egg (%)	Egg weight (g/egg)	Feed consumption (g/hen per d)	Feed efficiency (g feed/g egg)	Viability (%)
HL		72.76±0.772	71.69±0.836	48.25±0.519	1.37±0.082	66.32±0.190	118.62±1.265	1.79±0.020	96.53±0.998
BN		73.85±0.757	72.25±0.995	51.06±0.437	1.97±0.188	69.18±0.343	121.75±0.815	1.76±0.014	95.49±1.620
Mean		73.30±0.541	71.97±0.641	49.66±0.418	1.67±0.115	67.75±0.321	120.18±0.792	1.77±0.012	96.01±0.940
Significance		NS	NS	**	**	**	*	NS	NS
FM Programs									
FW		74.60±0.930^{a}	73.48±1.247	50.39±0.784	2.07±0.333	67.54±0.609	121.53±1.064	1.80±0.018^{ab}	96.53±1.460
BB		71.29±0.926^{b}	70.74±0.938	48.43±0.654	1.52±0.196	67.95±0.623	118.56±1.432	1.75±0.022^{bc}	97.92±1.460
WB		72.42±1.184^{ab}	71.58±1.435	49.42±0.996	1.62±0.204	68.25±0.881	118.24±1.803	1.73±0.014^{c}	96.53±1.800
OB		74.90±0.870^{a}	72.10±1.492	50.39±0.832	1.47±0.100	67.25±0.453	122.40±1.676	1.82±0.028^{a}	93.05±2.518
Significance		*	NS	NS	NS	NS	NS	*	NS
Genotype x FM Programs									
HL	FW	74.42±1.795	72.46±2.285	49.17±1.153	1.32±0.187	66.07±0.152	120.52±1.275	1.83±0.019	94.44±2.720^{ab}
	BB	71.25±1.070	70.16±1.010	47.52±0.872	1.31±0.181	66.70±0.608	117.34±2.680	1.76±0.033	95.83±2.660^{ab}
	WB	72.31±2.229	72.31±2.229	47.94±1.543	1.39±0.221	66.29±0.446	114.67±0.780	1.73±0.022	100.00±0.000^{a}
	OB	73.05±0.891	71.86±1.283	48.38±0.649	1.45±0.121	66.22±0.236	121.93±3.470	1.84±0.056	95.83±1.390^{ab}
BN	FW	74.79±0.889	74.50±1.158	51.61±0.741	2.82±0.327	69.00±0.525	122.54±1.725	1.78±0.028	98.61±1.390^{a}
	BB	71.33±1.689	71.33±1.689	49.34±0.828	1.72±0.343	69.21±0.625	119.78±1.185	1.73±0.034	100.00±0.000^{a}
	WB	72.53±1.249	70.84±2.069	50.91±0.882	1.85±0.332	70.21±0.929	121.81±2.460	1.73±0.020	93.06±2.660^{ab}
	OB	76.75±0.667	72.34±2.949	52.40±0.339	1.50±0.176	68.28±0.441	122.88±0.955	1.80±0.014	90.28±4.745^{b}
Significance		NS	NS	NS	NS	NS	NS	NS	*

* - Significant (P <0.05); ** - Significant (P <0.01); NS – No Significant; HL - White egg layer (Hy-Line W-36); BN- Brown egg layer (H&N Brown Nick); FM - Forced molting; FW - Feed withdrawal; BB - Barley based; WB - Wheat bran-corn based; OB - Oat based

Table 5. Effect of different genotype and forced molting programs on internal and external egg quality post molt ($\overline{X} \pm S_{\overline{X}}$).

Genotype		Albumen height (mm)	Haugh units	Shell thickness (mm)	Specific gravity (g/cm^3)
HL		7.22±0.041	82.54±0.268	0.335±0.0008	1.079±0.0002
BN		7.10±0.047	80.95±0.310	0.349±0.0010	1.082±0.0003
Mean		7.16±0.031	81.74±0.208	0.342±0.0007	1.081±0.0002
Significance		*	**	**	**
FM Programs					
FW		7.03±0.065^{b}	80.92±0.444^{b}	0.341±0.0014	1.080±0.0003
BB		7.22±0.063^{a}	81.97±0.420^{a}	0.342±0.0015	1.081±0.0002
WB		7.19±0.061^{a}	81.89±0.398^{a}	0.343±0.0014	1.081±0.0003
OB		7.21±0.062^{a}	82.20±0.396^{a}	0.343±0.0014	1.081±0.0005
Significance		*	*	NS	NS
Genotype x FM Programs					
HL	FW	7.10±0.078^{abc}	81.86±0.527^{bc}	0.336±0.0017	1.080±0.0005^{a}
	BB	7.38±0.079^{a}	83.37±0.512^{a}	0.333±0.0016	1.079±0.0003^{b}
	WB	7.11±0.082^{abc}	81.96±0.542^{bc}	0.335±0.0015	1.080±0.0004^{a}
	OB	7.30±0.087^{ab}	82.98±0.554^{ab}	0.335±0.0015	1.079±0.0003^{b}
BN	FW	6.95±0.104^{c}	79.97±0.699^{d}	0.346±0.0021	1.081±0.0004^{a}
	BB	7.07±0.095^{bc}	80.57±0.621^{cd}	0.350±0.0020	1.082±0.0003^{a}
	WB	7.26±0.089^{ab}	81.81±0.587^{bc}	0.351±0.0020	1.083±0.0005^{a}
	OB	7.12±0.087^{abc}	81.43±0.555^{c}	0.351±0.0019	1.082±0.0009^{a}
Significance		**	*	NS	*

** - Significant (P <0.05); ** - Significant (P <0.01); NS – No Significant; HL - White egg layer (Hy-Line W-36); BN- Brown egg layer (H&N Brown Nick); FM - Forced molting; FW - Feed withdrawal; BB - Barley based; WB - Wheat bran-corn based; OB - Oat based*

There were no differences in shell thickness and specific gravity for molting treatments. However, shell thickness and specific gravity were higher (P<0.01) in BN hens than HL hens.

CONCLUSIONS

Responses of brown and white egg laying hens to forced molting programs examined with respect to production and quality performances in current research. The below concluding remarks could be drawn from the results obtained.

Conventional FW programs were blamed for stress and *S. enteritidis* development condition. According to the result obtained in this research, non-FW programs can be applicable without any beneficial lost. These programs could be implemented with diets including low level of ME (2200 Kcal/kg) and CP (12-13%), no salt, 1% Ca, 0.5% non-phytate P, more than 10 % CF and adequate level of vitamins and amino acids. This type of diets can be formulated using local feed ingredients abundant in Turkey. But, cease of egg laying in these programs is not possible at all the time. If the stress is not the main problem for using this type of programs, water withdrawal for 1-2 day at the beginning, or when needed during the molting period, could solve this problem.

As to the production and quality performance results, even if OB (70% oat and 27% alfalfa) program was found as the favorite one, other two non-FW programs which are BB (70% barley and 27% alfalfa) and WB (32% wheat bran, 44% corn and 21% alfalfa) can also applicable as molting procedures. FW program used in this research can be further refined increasing the period to 10 days or the resting diet having less dense with respect to ME and CP content.

Further researches can be focused on to determine the level of stress which detrimental to laying hens, using standard methods. Because, even if FW program increased H:L ratio 4 times at 8th day of withdrawal period, non-FW programs also increased in the molting period two times as to the normal period.

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